TELETYPRE CORPORATION
SCHOOL OF MAINTENANCE TRAINING
201 NORTH WELLS STREET
Chicago 6, Illinois

M-28 ASR TAPE LINE EQUIPMENT
TRAINING COURSE

STUDENT'S GUIDE

FOR INSTRUCTION PURPOSES ONLY
SCHOOL INFORMATION

The Customer Service School provides, tuition-free, training for the maintenance personnel of Teletype's customers. As the School of Training is maintained for the customer, it is under the supervision of the Sales department.

Because there is no charge for the training provided, the Teletype Corporation will not assume the responsibility for making student's hotel reservations. For military personnel the School will, upon request, issue a form indicating time of arrival and departure. No certificate of non-availability of aircraft, rations or quarters will be issued.

Classes begin at eight o'clock and are in session until four forty-five in the afternoon. Breaks are scheduled for both morning and afternoon and a one hour lunch period is provided. Students may bring their lunch or eat at any of the numerous restaurants in the area. There are no classes on Saturdays.

Students are requested to observe the hours of the class and to be on time following each break. No extra training will be given students who come in late. Students who are repeatedly late will be asked to leave.

All text materials such as bulletins, charts and rulers may be retained by the student. Students are required to have a pen and/or pencil.

Although the classes are scheduled to run through four forty-five of the final Friday, some students complete the course earlier than others. Those who finish early may leave but no student may leave without completing the course unless he has special permission. Teletype personnel may not leave the School at any time unless they have the permission of their supervisor, lunch and break periods excepted.

The school's telephone may be used ONLY by instructors and Teletype personnel on company business.

The address and telephone number of the school is:

ADDRESS     201 N. Wells Street

PHONE        Financial 6-0586

Your instructors will be:
Description of the Course

The purpose of this course is to train personnel in the maintenance of the Model 28 Automatic Sending and Receiving Set.

The course is scheduled for a 3 week period and will cover theory, disassembly, adjustments of principle components, also testing and operation of complete set.

The student is urged to take notes for future reference and to ask questions so that he may derive the maximum benefit from the course.
Literature

Literature in the form of Teletype bulletins, specifications and wiring diagrams will be furnished each student.

List of Literature

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<td>Single Contact Transmitter Distributor</td>
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<td>242B Theory</td>
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<td>1170B Parts</td>
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<td>Fixed &amp; Pivoted Head Trans, Dist.</td>
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<tr>
<td>1124B Tool Bulletin</td>
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In addition to the above, Western Union trainees receive:

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<thead>
<tr>
<th>Bullets</th>
<th>Description</th>
<th>Teletype Code</th>
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<tr>
<td>244B Theory</td>
<td>Multimagnet Reperforator</td>
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<tr>
<td>245B Adj.</td>
<td>Multimagnet Reperforator</td>
<td>LARP</td>
</tr>
<tr>
<td>1166B Parts</td>
<td>Multimagnet Reperforator</td>
<td>LARP</td>
</tr>
</tbody>
</table>

A. T. & T. Co. and all Telephone Co. trainees will also receive:

<table>
<thead>
<tr>
<th>Bullets</th>
<th>Description</th>
<th>Teletype Code</th>
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</thead>
<tbody>
<tr>
<td>234B Theory, Adj. &amp; Lub.</td>
<td>Multiple Wire Distributor</td>
<td>LD</td>
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<tr>
<td>1159B Parts</td>
<td>Multiple Wire Distributor</td>
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In ordinary telegraph transmission, intelligence is relayed from one point to another by the making and breaking of the signal line. An operator at one end would open or close a telegraph key and cause a sounder at the receiving end to emit pulses of sound which could then be translated into characters by the other operator, trained to recognize the various code combinations. During the latter part of the nineteenth century, telegraphy took a step forward by substituting a mechanical sending mechanism for the old telegraph key, and a printer for the receiving station.

The new method of printing telegraphy, however, required modification of the old signaling method. The primary change has been in time control of the transmitted pulses. Specified time intervals or pulse lengths have replaced the, somewhat arbitrary, dot-dash system.

As devised by Jean Baudot, a French Signal Officer, the newer code requires that each character have a certain number of current and no-current time intervals (MARK or SPACE pulses) to indicate a particular code combination. It was decided that the intelligence portion of each complete character should have five of these time intervals. It may be seen that with two possibilities (MARK or SPACE) for five pulses:

$$2^5 = 32$$

possible code combinations.

Therefore, with the addition of an upper case, (figures) the Teletype Printer is capable of performing twice as many operations (printing or performing a function) as the number of available code combinations. In the lower case, or letters, we have the 26 letters of the alphabet plus 6, so-called, "functions". These functions are mechanical operations of the printer as opposed to the actual printing of a character. They include:

Letters (LTRS) = Either shifting the typebox to the letters segment or, as in the ML5, shifting the platen down.

Figures (FIGS) = Just the opposite of letters

Space = Moving the printing mechanism to leave a blank between words.

Carriage Return (C.R.) = Returning the printing mechanism to the left margin.

Line Feed (L.F.) = Feeding the paper out of the printer.

Blank = All pulses spacing -- used for various operations

The length or time duration of the individual pulses is determined by the operating period of the various cams and levers that cause the signal line contacts to open and close. It may be seen, then, that as the operating speed increases, the pulse length decreases.
At this time three basic speeds are in popular usage. They are: 368rpm; 460rpm; and 600rpm. An expression, of these speeds, in "words-per-minute" has been roughly approximated by dividing each figure by 6. (This assumes that a "word" is composed of five characters and a space). Thus, 368 becomes 60 words-per-minute, 460 becomes 75 words-per-minute and 600 becomes 100 words-per-minute. For maintenance or other technical purposes, however, it is far more accurate to deal only with actual shaft speeds.

If, for every revolution of the transmitting shaft, a complete character is transmitted, we may refer to 368 characters or 368 operations-per-minute (opm). This breaks down:

(a) \[
\frac{368}{60} = \text{operations-per-second} = 6.13
\]

(b) \[
\frac{1 \text{ second}}{6.13} = \text{length of one operation} = .163
\]

(c) At 368opm, then, one operation take .163 seconds or: \[
163 \text{ milliseconds (ms.)}
\]

To maintain synchronism between the sender and the receiver, it is necessary to establish a starting point and a stopping point. Consequently, to our character combination of five pulses there has been added a START pulse and a STOP pulse. These pulses are not considered information pulses. In the systems used by most companies, the START pulse is the same length as an information pulse while the STOP pulse is somewhat longer. The STOP pulse is longer to insure that the receiving machinery has time to complete detection of the last information pulse before the transmitter begins a new character. The STOP pulse, in most cases, is \(1.42\) (or \(142\%\)) times as long as the START or information pulse. If we designate the START (or standard pulse length) as 1 unit, we have:

(d) \[
\begin{align*}
\text{START} &= 1 \text{ Unit} \\
\text{Information pulse} &= 5 \text{ Units} \\
\text{STOP} &= 1.42 \text{ Units}
\end{align*}
\]

\[
7.42
\]

(e) \[
7.42 \text{ is known as the UNIT CODE}
\]

Western Union, as an alternate example, has a STOP pulse the same length as the START or information pulse. With all seven pulses the same duration, Western Union would be operating with a 7.00 Unit Code.

To determine the time duration of any pulse:

(f) \[
\frac{.163 \text{ sec (time for one complete operation)}}{7.42 \text{ (units)}} = 21.96 \text{ or } 22\text{ms.} = 1 \text{ Unit}
\]

(g) \[
21.96 \times 1.42 = 31.18\text{ms or } 31\text{ms}
\]

(h) The START or information pulse (1 Unit) = 22ms.

(i) The STOP pulse (1.42 Units) = 31ms.
The normal, or "rest" condition of the signal line is closed, that is, with current on the line. If the normal condition is closed, the beginning or START pulse must alter that condition. Obviously, then, the START pulse must be no-current or SPACING. The end of the transmission must return the signal line to its normal condition so the STOP pulse must be current or MARKING. As seen on an oscilloscope and assuming no distortion, the character 'Y' would look like this:

![Diagram](image)

The character 'Y' is most often used for illustration and test purposes because every other pulse is different. As indicated on the rulers, however, the information pulses (between the START and STOP pulses) may vary according to the character selected. It has been noted that the STOP pulse is 1.42 times as long as the START or information pulse. This, of course, assumes continuous operation. Otherwise the STOP pulse might be 31ms, 31 minutes or ten days -- depending upon when the next character was transmitted.

**POLAR OPERATION:** Up until now, only NEUTRAL operation has been considered. In Neutral operation, a SPACING is when there is no-current on the line and a MARK is when there is current on the line (60ma or 70ma). In Polar operation, there is current on the line at all times and it is the difference between the current polarity that determines whether a MARK (+) or a SPACING (−) is being transmitted. Obviously the printer could not be hooked, directly, to a polar signal because current, no matter what polarity, would energize the selector magnets.

**BAUD (from Baudot):** An expression which combines shaft speed (operations-per-second) and unit code into one usable term or figure. It also indicates the maximum number of pulses-per-second. It is derived by multiplying the operations-per-second by the unit code:

\[
\text{k) \quad \frac{360 \text{ ops/sec}}{60} = 6.13 \text{ ops/sec} \times 7.42 \quad (\text{Unit Code}) = 45.5 = \text{Baud}
\]

In the case of Western Union, both the operations-per-second and shaft speed differ:

\[
\text{l) \quad \frac{390 \text{ ops/sec}}{60} = 6.5 \text{ ops/sec} \times 7.00 \quad (\text{Unit Code}) = 45.5 = \text{Baud}
\]
It may be seen, in the above illustrations, that although both shaft speed and unit code differ, and Western Union machine may operate with any Teletype product because their BAUD is the same.

**DOT CYCLE FREQUENCY**: Each MARK-to-SPACE transition comprises a rectangular wave. Any rectangular wave is made-up of a fundamental sine wave plus a number of sub harmonic frequencies. This fundamental, or Dot Cycle Frequency of any character may be determined by dividing the length of one MARK-to-SPACE transition into one. Inasmuch as the character 'Y' changes from MARK to SPACE every other pulse, one MARK-to-SPACE transition would be equal to the length of two pulses or 0.044sec.

\[
\frac{1}{.044} = \text{approx. 23cps = Dot Cycle Frequency of character 'Y'}
\]

The character 'W' (3,4 & 5 MARK) does not have as many transitions as 'Y'. For 'W', the START, first and second pulse would be one part, while the third, fourth and fifth pulses would be the other part of its rectangular wave form.

\[
\begin{align*}
\text{(m)} & \quad \text{START + First + Second} = 66\text{ms}.
\text{Third + Fourth + Fifth} = 66\text{ms}.
\text{132ms}.
\end{align*}
\]

\[
\frac{1}{.132} = \text{approx. 8cps = Dot Cycle Frequency of character 'W'}
\]

The Dot Cycle Frequency is important in determining the necessary bandpass for Teletype transmission. If the highest frequency can get through, all others may. Consequently, the character 'Y', with the maximum number of transitions, provides this maximum or reference frequency. It has been found that the fundamental frequency plus the next ten or eleven harmonics provides a good signal. The BELL system, however uses only the third or fourth (around 89cycles) for their bandpass.
For purposes of illustration Teletype pulses are shown as perfect rectangular waveshapes with sharp transitions and precise timing. This optimum condition is seldom, if ever, found in actual practice.

The modification of the original, rectangular waveshape is called Distortion. The Total Distortion to any signal is broken-down into three categories for purposes of classification but it is important to note that any signal may contain all three components of distortion. The three components of distortion are:

Bias Distortion
Characteristic Distortion
Fortuitous Distortion

Bias and Characteristic Distortion are combined in the term Systematic Distortion because both occur in response to natural law and, consequently, either is roughly predictable. With the third element, Fortuitous Distortion, every possible modification is accounted for — and labeled Total Distortion.

Bias Distortion

Bias Distortion effects all pulses uniformly and its effect upon a MARK is opposite to its effect upon a SPACE. Bias may effect either the beginning or the end of an impulse but inasmuch as the selector always begins with the MARK-to-SPACE transition of the Start pulse, the total effect of bias is to advance or retard the leading edge of any impulse with respect to the Start pulse.

Before illustrating Bias, it will be necessary to indicate the effect, upon a signal pulse, by the resistive, inductive and capacitive elements in the signal line.

1. Perfect MARK impulse

2. Line INDUCTANCE opposes sudden transitions of current. Inductance from Line Relays and/or selector magnet coils.

3. Line CAPACITANCE shunts the signal line preventing rapid current build-up and, thus, further sloping the edges of the wave.
The impulse in figure 3 is more likely to be found at the receiving printer than the one (figure 1) impressed at the transmitter. The impulse seen in figure 3, as applied to the selector magnets of the printer, will be used to illustrate Bias Distortion. It will be noted that this waveshape builds up to its 60ma level gradually - due to the reactive elements of the signal line.

Instead of picking-up at the leading edge of the pulse (T1), the selector magnet will energize at a somewhat later time -- say, for example, at T2 -- or whenever the current has reached a level where it generates sufficient magnetic attraction. This point, T2, would be the beginning of the MARK impulse as far as the selector was concerned.

When, at the end of the transmitted pulse, the current again starts towards 0ma, the selector armature should, theoretically, fall away at T3. The trailing edge of the impulse, however, also slopes and, consequently, a definite time will have elapsed before the armature will drop away (T4). Notice that T2 and T4 are not identical current values. The de-energization point will be a lower value due to residual magnetism in the coils and, conceivably, to weak spring tension.

The time between when the armature should attract (T1) and when it does attract (T2) is known as **SPACE-to-MARK TRANSITION DELAY**. (abbreviated **S-MTD**)

The time between when the armature should drop away (T3) and when it does drop away (T4) is known as **MARK-to-SPACE TRANSITION DELAY** (**M-STD**).

If the S-MTD is equal to the M-STD, the pulse as seen by the selector would be undistorted.

If the S-MTD is greater than the M-STD the pulse has been shortened and the condition is known as **SPACING BIAS**.

If the M-STD is greater than the S-MTD the pulse has been lengthened and the condition is known as **MARKING BIAS**.

The Bell System uses the following formula to determine the actual Bias condition in milliseconds (ms.). The sign of the result indicates whether the Bias is MARKING (+) or SPACING (-).

\[ M-STD - S-MTD = \text{ms. Bias} \]
This example of Bias Distortion illustrates that although the K-STD may not equal the S-MTD, the two will be consistent for any given circuit and/or adjustment. It will be noted, also, that the effect of Bias will:

a) Be the opposite to a SPACE from its effect upon a MARK.
b) Be consistent for any character combination.

Characteristic Distortion

Characteristic Distortion, as the name implies, is determined by the signal line characteristics. That is, the resistance, capacitance and inductance. This type of distortion will effect different characters in different ways but it will always be consistent for the same character. In neutral operation, Characteristic Distortion will effect Bias.

Characteristic Distortion has varying effects upon different characters because the circuit's reactance will have less chance to become stabilized when characters with many current transitions are applied ( 'Y', for example ) than when characters with few transitions are applied ( 'M', for example ). It may be said that the effect of Characteristic Distortion is inversely proportional to the Dot Cycle Frequency of the character transmitted.

The contrasts between Characteristic Distortion and Bias may be summarized as follows:

1. The effect of Characteristic Distortion depends upon the length of the impulse transmitted. The effect of Bias is independent of the length of the impulses.

2. For a given length of impulse, the effect of Characteristic Distortion is independent of whether it is a marking or spacing impulse. The effect of Bias is always opposite on a mark to what it is on a space.

3. Characteristic Distortion is related to the amount and arrangement of the capacitance, inductance and resistance of a circuit. Except in neutral operation, these factors do not effect Bias.

4. Bias is caused by unequal marking and spacing line current, biased relays etc., conditions which do not effect Characteristic Distortion.

5. Characteristic Distortion, because it is due to the capacitance, inductance and resistance of a circuit, which, except for the resistance, are unchanging in value, varies only a small amount from day to day. Bias, because it is caused by uneven potentials, relays losing adjustment etc., may vary from hour to hour.
Fortuitous Distortion

This form of distortion covers such unpredictable occurrences as sudden battery fluctuations or loose ground connections. This distortion may effect any portion of any character and little or no compensation may be made for it.

Range

All Teletype receivers (i.e. printers, perforators etc.) are equipped with a range scale. In every case, the function of the range scale is to orient the mechanical selector to the electrical signal to obtain maximum selecting margins.

The selecting interval of the impulse (i.e. when the actual selection is made) is only 20% of the pulse width or 4.4ms. Consequently a perfect selector should be able to tolerate 40% distortion of both leading and trailing portions of an impulse.

In a perfect impulse of 22ms duration, the necessary 20% selecting interval would be in the center with a range reading of 10 to 110:

![Diagram of range scale](image)

If 20% MARKING END DISTORTION (an artificially produced characteristic distortion used to test acceptance— in this case it would extend the leading edge of the pulse) were introduced, the range would shift in order to maintain the selecting interval in the middle of the pulse:

![Diagram of range scale with distortion](image)
If 20% SPACING END DISTORTION were introduced the range would shift in an opposite direction:

\[ 30 \pm \frac{10}{2} \]

In any situation there is a standard procedure for determining the proper setting for the range scale:

a) Determine the high and low points on the range scale by observing errors in copy.

b) Add the high point to the low point and divide by two. (See examples in range illustrations.)

Most of the information on Signal Distortion and Range was taken from:

**PRINCIPLES OF ELECTRICITY APPLIED TO TELEPHONE & TELEGRAPH WORK - A.T.&T Long Lines Div.**
(1953)

**MEASUREMENT OF SELECTING MARGINS - W.J. Zenner** (1937)

**FEDERAL AIRWAYS MANUAL OF OPERATIONS, Vol. IV Civil Aeronautics Adminis.** (1944)

**TELETYPEWRITER TRAINING MATERIAL - A.T.&T. Co.** (1947)
### ASR Set of Tools

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<tr>
<td>2.</td>
<td>32 oz. scale</td>
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<tr>
<td>3.</td>
<td>64 oz. scale</td>
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<tr>
<td>4.</td>
<td>set of gauges (#117781)</td>
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<tr>
<td>5.</td>
<td>(2) off set screwdrivers (90°) (30°)</td>
</tr>
<tr>
<td>6.</td>
<td>screwdriver (large)</td>
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<tr>
<td>7.</td>
<td>screwdriver (small)</td>
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<tr>
<td>8.</td>
<td>#8 crochet hook</td>
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<tr>
<td>9.</td>
<td>#12 crochet hook</td>
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<tr>
<td>10.</td>
<td>spring hook (push)</td>
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<tr>
<td>11.</td>
<td>spring hook (pull)</td>
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<tr>
<td>12.</td>
<td>screw holder with blades</td>
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<td>13.</td>
<td>armature clip</td>
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<tr>
<td>14.</td>
<td>hand wheel</td>
</tr>
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<td>15.</td>
<td>wrench – 3/16&quot; - 1/4&quot;</td>
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<td>16.</td>
<td>wrench – 5/16&quot; - 3/8&quot;</td>
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<tr>
<td>17.</td>
<td>wrench – 9/16&quot; - 3/4&quot;</td>
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<td>18.</td>
<td>tommy wrench</td>
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<tr>
<td>19.</td>
<td>contact adjusting tool (#156170)</td>
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<tr>
<td>20.</td>
<td>tape lid gauge (#156743)</td>
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<tr>
<td>21.</td>
<td>top plate adjusting gauge (#159133)</td>
</tr>
<tr>
<td>22.</td>
<td>punch bail arm gauge w/pin (#159926)</td>
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<tr>
<td>23.</td>
<td>tape gauge w/pins (#156011)</td>
</tr>
<tr>
<td>24.</td>
<td>hexagon key wrench (#104457)</td>
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<tr>
<td>25.</td>
<td>&quot; &quot; &quot; (#159841)</td>
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<tr>
<td>26.</td>
<td>&quot; &quot; &quot; (#124682)</td>
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<tr>
<td>27.</td>
<td>key lever remover</td>
</tr>
<tr>
<td>28.</td>
<td>tweezers</td>
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<tr>
<td>29.</td>
<td>wrench #129534 – 3/16&quot; - 1/4&quot;</td>
</tr>
</tbody>
</table>
Depressing KEYLEVER operates

CODE LEVER rotates

UNIVERSAL BAIL rotates and allows

UNIVERSAL BAIL LATCH LEVER to move down and release CODE BAR BAIL LATCH allows

CODE BAR BAIL to move to right

CLUTCH TRIP BAR and all selected

CODE BARS move to right

CLUTCH STOP LEVER trips

CLUTCH and CAM SLEEVE rotates.

CODE BARS

(unselected code bars are blocked by the operated code lever)
selected CODE BARS move
code bar VERTICAL EXTENSION
engage TRANSFER LEVER
rotate TRANSFER BAIL
operates DRIVE LINK
operates CONTACT TOGGLE
actuates CONTACTS
SIGNAL GENERATOR SHAFT rotates
ECCENTRIC FOLLWHER and
CODE BAR BAIL moves to left, allowing
CODE BAR BAIL LATCH to move up, latching
NEEDLE BEARING STUD.

CODE BAR BAIL moving left engages
permutated CODE BARS
CLUTCH TRIP BAR
NON-REPEAT LEVER
IN K-T POSITION
CLUTCH TRIP BAR moves to right
LATCH engages
CLUTCH TRIP BAR LINK
PERFORATOR TRIP LEVER LATCH operates
PERFORATOR TRIP LEVER releases
CLUTCH RELEASE and
FUNCTION CLUTCH TRIP LEVER (not shown)

CLUTCH IS DISENGAGED
WHEN CLUTCH RESET CAM
RIDES HIGH PART OF RESET PIN.
selected CODE BARS operate allowing
CODE BAR EXTENSIONS to move to right
rotating PUNCH SLIDE LATCH freeing selected
PUNCH SLIDES
(PUNCH SLIDE BIAS SPRING operates PUNCH SLIDES)

BLOCKING BAIL to right freeing CODE BAR EXTENSIONS
in K-T and T position, to left, blocking CODE BAR
EXTENSIONS in K position
RESET CAM revolves
RESET CAM FOLLOWER ARM operates
RESET LEVER actuates
KEYBOARD CONTROL SELECTION LEVER moves left operating
CLUTCH TRIP BAR resetting
CODE BAR BAIL
CODE BARS
NON-REPEAT LEVER
ROCKER BAIL operates (after function clutch trips)
PERFORATOR DRIVE LINK actuates
ROCKER ARM rotates
TOGGLE SHAFT operates
TOGGLE BAIL counterclockwise
SLIDE POST moves up driving the selected
PUNCH SLIDES up striking
PUNCH PINS driving PINS through the tape
current applied to the CLUTCH MAGNET causes the ARMATURE BAIL EXTENSION to rise and free CLUTCH TRIP LEVER LOWER EXTENSION which rotates UPPER TRIP LEVER moves away from CLUTCH SHOE LEVER allowing the CLUTCH to become engaged and the CAM SLEEVE comences to rotate

resetting occurs as the RESET CAM rotates TRIP LEVER RESET EXTENSION which rotates shaft and presents UPPER TRIP LEVER in path of CLUTCH SHOE LEVER thus disengaging CLUTCH
FEEDING FIXED READER
FEEDING PIVOTED READER

SENSING CAM SLEEVE rotates
FEED LEVER operates
FEED PAWL BAIL moves
FEED PAWL down rotating
FEED WHEEL one space
* CAM FED SPRING RETURNED

SENSING CAM SLEEVE rotates allowing
FEED LEVER SPRING (not shown) to operate
FEED LEVER moves
FEED PAWL up rotating
FEED WHEEL one space
* SPRING FED CAM RETURNED
STRIPPING

SENSING CLUTCH trips permitting SENSING CAM SLEEVE to rotate PUSH LEVER BAIL strips PUSH LEVERS from SENSING PINS

SENSING

SENSING BAIL CAMS (2) allow SENSING BAIL and SENSING PINS to rise & sense tape.

PUSH LEVERS fall under selected sensing pins LATCH BAIL strips off LATCH LEVERS from CONTACT LEVER SLIDE allowing CONTACTS to open, erasing last character in STORING BLOCK

CONTACTS OPERATING

SENSING BAIL operates SENSING PINS moving selected PUSH LEVERS moving CONTACT LEVER SLIDES down allowing CONTACT to close
SENSING CAM SLEEVE rotating causes
AUXILIARY LEVER to move down against
PUSH LEVER moving
CONTACT LEVER SLIDE down permitting
CONTACT LEVER EXTENSION to drop allowing
CONTACT to close
closing auxiliary contact on pivoted or fixed sensing mechanism causes DISTRIBUTOR CLUTCH to become energized allowing DISTRIBUTOR CAM SLEEVE to rotate permitting CAM FOLLOWER LEVERS to fall into low part of cam (sequentially) permitting DISTRIBUTOR CONTACTS to close generating a TELETYPE signal.
Start pulse received in SELECTOR MAGNET COILS releases ARMATURE unblocks
START LEVER releases
STOP ARM BAIL and STOP ARM
CLUTCH trips and SELECTOR CAM SLEEVE rotates
PUSH LEVER RESET BAIL resets
PUSH LEVERS to the rear (spacing ) position

ARMATURE attracted (marking ) permits ARMATURE unattracted (spacing ) blocks
SELECTING LEVER to move behind MARKING LOCK LEVER
PUSH LEVER drops down MARKING LOCK LEVER EXTENSIONS block
SELECTING LEVER moves SELECTING LEVER causing PUSH LEVER to remain on top of SELECTING LEVER and to the rear in its spacing position
PUSH LEVER forward to its marking position
**Movement of the Start Lever**

1. The armature drops down for the first pulse, the START
   pulse, which is always SPACING. The Start lever drops
   over the armature extension, holding the armature spacing. The
   Start lever is connected to the Stop Arm Bail — as the Start
   Lever moves over the armature extension, the Stop Arm Bail
   is forced into the indent of its cam — causing the Selector
   Clutch Stop Arm (shown as one piece with the Bail, for illus-
   tration purposes) to fall away and allow the clutch to engage
   and begin rotating.

2. As the Selector cam begins rotating, the reverse action
   takes place. The Stop Arm extension rides to the high
   part of the front cam, forcing the Start Lever clear of the
   armature extension and pulling the Selector Clutch Stop Arm
   back against the clutch drum where it will be in position
   to stop the Selector clutch after one revolution.

**NOTE:** Because the Stop Arm Bail Cam (Front Cam) has only
one indent, the Start Lever may not fall over the armature
again during the cycle.
SELECTOR MECHANISM DURING SPACING IMPULSE

1. Magnets are de-energized and armature drops down. Spacing Lock Lever falls over top of armature, holding it spacing. Spacing Lock Lever rides into indent of double (LOCK) cam.

2. With the armature down (Spacing), the Marking Lock Lever is blocked. The projection on the Marking Lock Lever rides in the air over the indent in the double cam.

3. As the Selector cam indent comes into line, the Selector Lever attempts to move back into the indent. Because the Marking Lock Lever is being blocked by the armature (extension 2), the Selector Lever is blocked by the arm on the Marking Lock Lever. The Push Lever moves forward, slightly, but not far enough to drop off onto the Selector Lever Guide.

Note: BETWEEN EACH PULSE, THE MARKING AND SPACING LOCK LEVERS RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE ARMATURE.
SELECTOR MECHANISM DURING MARKING IMPULSE

1. Magnets are energized and armature is pulled up. The Spacing Lock Lever attempts to move to the rear but is now blocked by the armature extension.

2. With the armature up (Marking), the Marking Lock Lever is free to be pulled to the rear by its spring. As it moves to the rear, it braces the armature against the pole pieces and rides into the indent of the double (Lock) cam. (The Spacing Lock Lever is, at this period, riding in the air above that same cam indent.)

3. The Marking Lock Lever is now out of the way so the Selector Lever, which has the indent of its cam available, may fall in. The indents of the other Selector cams have either passed or not yet arrived, consequently only one Selector may fall in during any given pulse. Moving to the rear, the Selector Lever can no longer support the Push Lever and, consequently, the Push Lever drops down onto the Selector Lever Guide. As the Selector rides out of its indent it will move forward which, in turn, will cause the Push Lever to be moved forward.

Note: BETWEEN EACH PULSE, THE MARKING AND SPACING LOCK LEVERS RIDE TO A HIGH PART OF THE DOUBLE CAM AND MOVE CLEAR OF THE ARMATURE EXTENSION.
MARKING SELECTOR LEVER moves to left operating
PUNCH SLIDE LATCH counterclockwise permitting
PUNCH SLIDE BIAS SPRING to operate the
PUNCH SLIDE to a marking position

(SPACING SELECTOR LEVER causes PUNCH SLIDE LATCH
and PUNCH SLIDE to remain stationary)
PUNCH SLIDE marking (to left) moves TRANSFER LEVER left rotating rear of PULSE BEAM to right allowing BELL CRANK to rotate counterclockwise positioning PUSH BAR up MARKING.

PUNCH SLIDE spacing all parts would remain stationary PUSH BAR would remain down SPACING.
SELECTOR CAM SLEEVE rotating causes
FUNCTION TRIP CAM to operate
FOLLOWER LEVER moving
ADJUSTING ARM up rotating
MAIN TRIP LEVER counterclockwise permitting
CLUTCH RELEASE to drop rotating
TRIP SHAFT moving
CLUTCH TRIP LEVER free of
CLUTCH SHOE LEVER permitting
CLUTCH ENGAGEMENT and rotation of
FUNCTION CAMS.

resetting occurs as
ECCENTRIC PIN moves
RESET ARM rotates
TRIP SHAFT presenting
CLUTCH TRIP LEVER into path of
CLUTCH SHOE LEVER disengaging
FUNCTION CLUTCH
FUNCTION CLUTCH engaged causes
FUNCTION CAMS to rotate operating
UPPER and LOWER ROCKER BAIL ROLLERS moving
ROCKER BAIL operating
MOUNTING BAIL and moving
OPERATING BLADE left and right which will operate
the various PUSH BARS
OPERATING BLADE moving to left will operate selected* PUSH BARS which, through rack & gear arrangement, will operate ECCENTRIC ASSEMBLIES (3).

PUSH BARS #3, 4, & 5 control ECCENTRIC ASSEMBLIES on front of unit and provide rotary positioning of TYPE WHEEL.

PUSH BARS #1 & 2 control rear ECCENTRIC ASSEMBLY and provide axial positioning of TYPE WHEEL.

* Selected PUSH BARS - 1, 2, 3 & 4 on mark (up)
  5 on space (down) note construction #5
movement of #1 and/or 2
PUSH BAR causes
ECCENTRIC ASSEMBLY to rotate causing
CRANK PIN to move
OUTPUT RACK rotating
AXIAL SECTOR moving
CYLINDRICAL RACK and
TYPEWHEEL forward into one of 3 stops
The various selection of #3, 4, & 5 PUSH BARS to operate the right and/or left ECCENTRIC ASSEMBLIES operating the OUTPUT CONNECTING RODS moving the CROSS LINK operating TYPEWHEEL RACK rotating TYPEWHEEL SHAFT SPUR GEAR rotating the TYPEWHEEL into one of eight stops

LETTERS-FIGURES shift gives eight additional stops for a total of sixteen.
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Front View Showing 16 Longitudinal Rows

Top View Showing Cylindrical Surface in a Plane
PRINT
ROCKER BAIL operates
PRINTING DRIVE LINK rotating
PIVOT ARM pulling down
PRINTING TRIP LINK rotating
PRINTING LATCH permitting
ACCELERATOR SPRING to pull down
ACCELERATOR driving
PRINT HAMMER up against
RIBBON

RESET
ROCKER BAIL, PRINTING DRIVE LINK, PIVOT ARM & PRINTING TRIP LINK reverse their previous movements operating ACCELERATOR, PRINT HAMMER down allowing PRINTING LATCH to relatch
ROCKER BAIL ROLLER moves to left striking
DRIVE ARM moving
PAWL ASSEMBLY up rotating one of the
RATCHETS and its
RIBBON SPOOL advancing
RIBBON

RIBBON REVERSE occurs as
PAWL ASSEMBLY comes down striking
FRONT or REAR REVERSING ARM rotating
PAWL ASSEMBLY to opposite ratchet also
REVERSING LEVER is rotated allowing
RETTAINING PAWL to engage opposite
RATCHET

RIBBON will now be fed in reverse